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Study on a singly charged ion source for radioactive ^{11}C ion acceleration

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A new singly charged ion source has been developed to realize an ISOL (Isotope Separation On-Line) system for a PET imaging simultaneously with the heavy-ion cancer therapy using radioactive ^{11}C ion beams. In the ISOL scheme, ^{11}C molecules are firstly produced by irradiating boron compound target with proton beams provided by a small cyclotron. Then, 1+ ions are firstly produced from the ^{11}C molecules with the singly charged ion source. Finally, after the isotope separation with an analyzing magnet, the $^{11}C^{+}$ ions are further ionized by employing an EBIS/ESIS as a charge breeding ion source to obtain required charge state for the HIMAC injector.

The singly charged ion source employs a barium impregnated tungsten cathode and ionizes the ^{11}C molecules by electron bombardment. Because the singly charged ion source is required to have high ionization efficiency, effective flight paths of the electrons emitted from the cathode have to be extended. For that reason, magnetic field is applied in the ionization region of the ion source and its direction is set parallel to that of the ion extraction. To decide the geometric parameters of the ion source, ionization efficiency was estimated considering balance among inflow of molecules and outflow of molecules/ions from the ionization region. Based on those considerations, the electron bombardment ion source was designed and fabricated. Details of the design and experimental results showing its fundamental performances are to be presented.